Space Weather Technical Forecast

Issued on Saturday 12 October 2024 at 13:15 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Waning CME effects over the next 24 hours. Slight chance of G1/Minor Storm interval on Day 1 (12 Oct) and possibly late Day 2 (13 Oct). R1 Radio Blackouts are likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity at GOES16 and 18 has been Moderate, with a peak flare of M2.1 at 11/1633UTC from AR3854.

There are nine sunspot regions on the visible disc, three of which are currently unnumbered. AR3848 in the northwest, is the largest sunspot on the disc, which has shown some minor growth in its northern most spot, which may be showing signs of a tenuous 'delta' spot forming in its northern portion of its penumbra. This region remains classified as a Beta/Dho. AR3849 in the southwest has shown some minor decay in its intermediate and trailing spots. Meanwhile, further small bi-polar spots have emerged to the south of AR3849, which are currently labelled as a NEW region. Finally, AR3854 and AR3852 in the southeast disc, which continue to show some growth within their intermediate portions. Remaining spots are small and simple.

The aforementioned M2.1 flare from AR3854 produced a CME, which was seen in LASCO coronagraph imagery at 11/1748 UTC, off the east limb. This has been analysed and results suggest a glancing blow at Earth on Day 4 (15 Oct), with the bulk of the plasma ahead of Earth' orbit. This is currently low confidence due to missing imagery, therefore, further analysis is needed.

No other Earth-directed CMEs have been observed over the past 24 hours.

Solar Wind / Geomagnetic Activity: This 24-hour continued to show waning influences from the X1.8 (09 Oct) CME, which arrived at Earth on the 10 Oct.

The solar wind speed, recorded at L1 by DSCOVR and ACE started the period at very strong to strong levels, near 800 km/s, gradually declining to the current Elevated levels, near 580km/s. Density has been below average. The IMF was moderate at 10-11nT at the start of the period, gradually declining to weak levels. The north-south component, Bz, was weakly negative at -8nT, then became weak to moderate and mostly positive from around 11/1300 UTC, with a peak of +11nT at 11/2319 UTC. The phi angle varied between negative and positive.

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The resulting geomagnetic activity showed a gradual decline from the CME influence, with a G2/Moderate Storm interval at the start of the period, declining to become mostly Active to Unsettled (Kp3-4) into the UTC day. Geomagnetic activity has recently declined to Quiet (Kp2).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 has returned to background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 were largely at Normal Background at GEO, but did show some enhancement to moderate levels during the evening. The associated 24-hour fluence was well below the Active threshold. The 24-hour fluence values have been restored, with a 12/0000UTC value of 5.2e6.

Four-Day Space Weather Forecast Summary

Solar Activity: Further R1s remain Likely through this four-day period given developments on the disc, their complexity, and perhaps two arrivals over the eastern limb over the next 24 hours. The significant flare risk level is therefore almost flat - after an initial slightly higher risk from Ex-AR3842 should it produce any significant large events from beyond the west limb.

Solar Wind / Geomagnetic Activity: The effects from the 09 Oct X1.8 CME and filament eruption continue to influence Earth, but it's intensity continues to wane.

An M2.1 flare from AR3854 produced a CME, which was seen in LASCO coronagraph imagery at 11/1748 UTC, off the east limb. This has been analysed and results suggest a glancing blow at Earth on Day 4 (15 Oct), with the bulk of the plasma ahead of Earth' orbit. This is currently low confidence due to missing imagery, therefore, further analysis is needed.

A pair of potential coronal hole fast winds may affect the Earth late Day 2 (13 Oct), although confidence in any effects from these features is Low.

Geomagnetic activity is expected to gradually wane to predominately Quiet to Active conditions (Kp2-4), with a slight chance of G1/Minor Storm should either of the CH fast winds connect at Earth. A further enhancement is possible by Day 4 (15 Oct) due to a glancing blow from a CME, which left the Sun on 11 Oct, although this is Low confidence.

Energetic Particles / Solar Radiation: Further risk of S1/Minor storms until Day 2 (13 Oct) due to the presence of Ex-3842 beyond the west limb.

High energy electron flux is now at Normal Background. A rising Slight Chance of recovery of fluence may occur later in the UTC weekend, before any possible fast winds arrive, although the effect of these should be limited.

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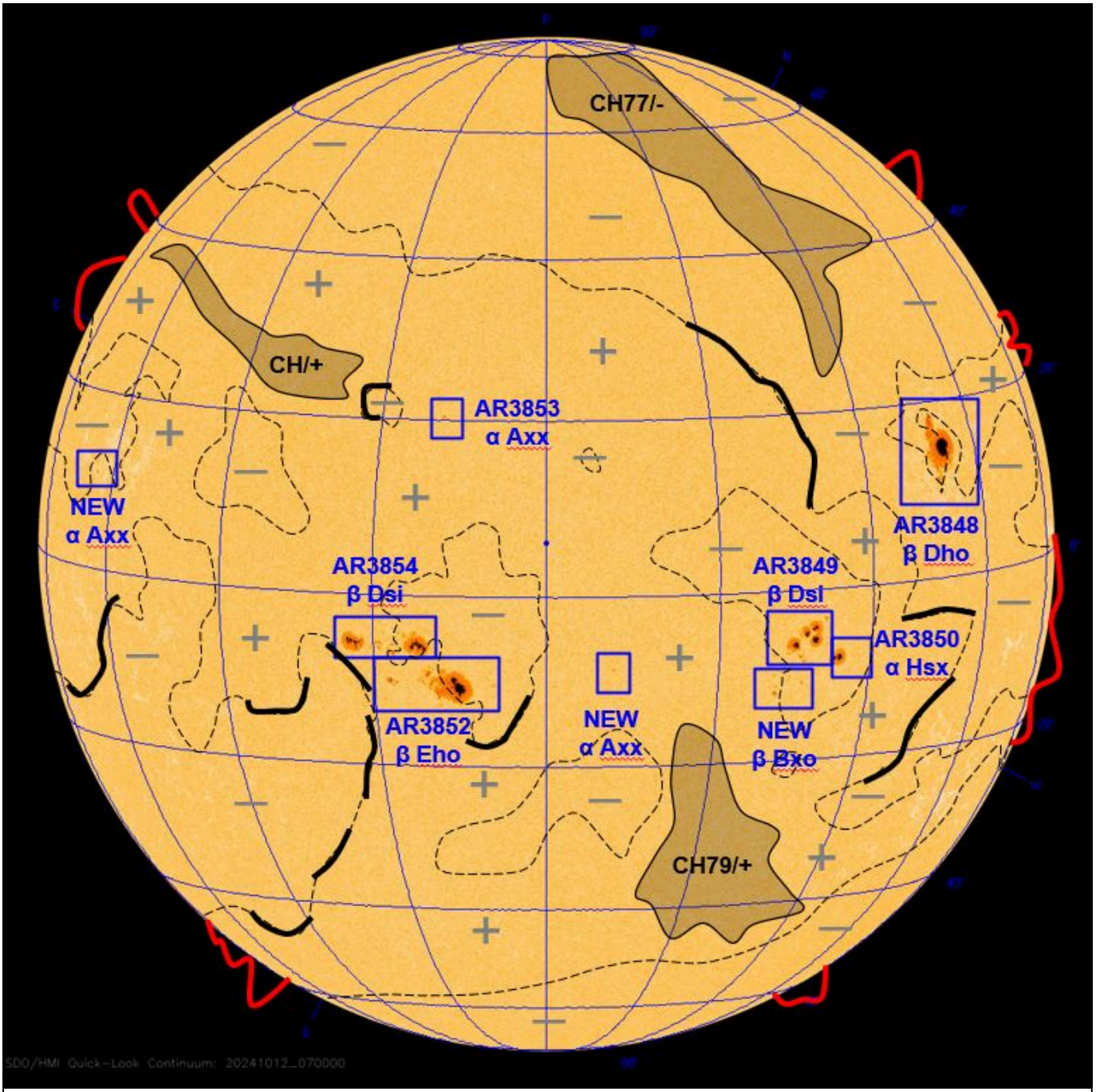
Figure 1: MOSWOC - Solar Synoptic Map, valid 12/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The CME from the 09 October X1.8 flare and filament eruption is continuing to affect Earth, but its intensity continues to wane. One other CME possibly features in the forecast,

An M2.1 flare which originated from AR3854 produced a CME, which was seen in LASCO C2/C3 coronagraph imagery at 11/1748 UTC, lifting off the east limb. This has been analysed and results in ENLIL suggest a glancing blow at Earth on Day 4 (15 Oct), with the bulk of the plasma ahead of Earth' orbit. This is currently low confidence due to missing imagery, therefore, further analysis will be conducted once further imagery becomes available.

A pair of potential coronal hole fast winds may affect Earth late Day 2 (13 Oct), although confidence in any effects from these features is low. Earth may potentially 'thread the needle' between these northern and southern hemisphere features. CH79/+ in the south has retreated pole-ward compared to last rotation and appears more tenuous, and therefore any connection with Earth is likely to be weak, with any fast wind approaching 450km/s. Alternatively, CH77/- also stands a chance of connecting around the same time, however its apparent greater intensity (versus CH79/+ from e.g. AIA211 imagery) will be mitigated against by its unfavoured polarity.

There is a slight chance of G1 Minor/Storm (Kp 5) intervals Day 1 (12 Oct), but activity continuing to wane further through the day to predominately Quiet-Active levels (Kp2-4) with a low confidence Slight Chance of G1 should either of the coronal holes' fast winds impinge on Earth from late Day 2 (13 Oct). A further enhancement is possible by Day 4 (15 Oct) if a glancing blow from a CME (which left the Sun on 11 Oct) arrives at Earth, with a Slight Chance of a G1/Minor Storm. This is currently low confidence.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	10	10	5	10
Strong	**G3**	No	1	1	1	0
Severe	**G4**	No	1	1	1	0
Extreme	**G5**	No	1	1	1	0

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Figure 2: MOSWOC ENLIL - shows a possible glancing CME on Day 4 (15 Oct). This is currently low confidence.

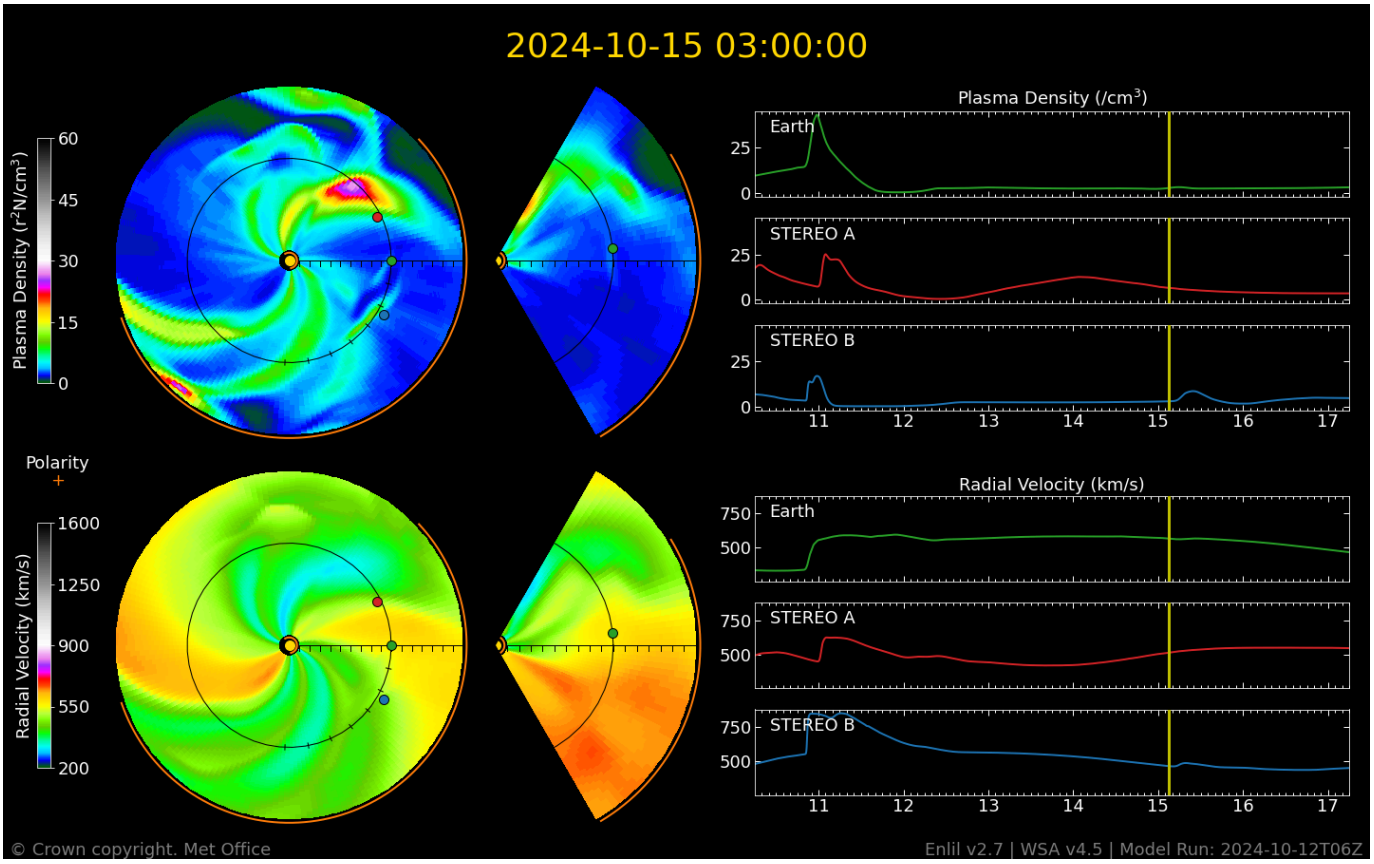

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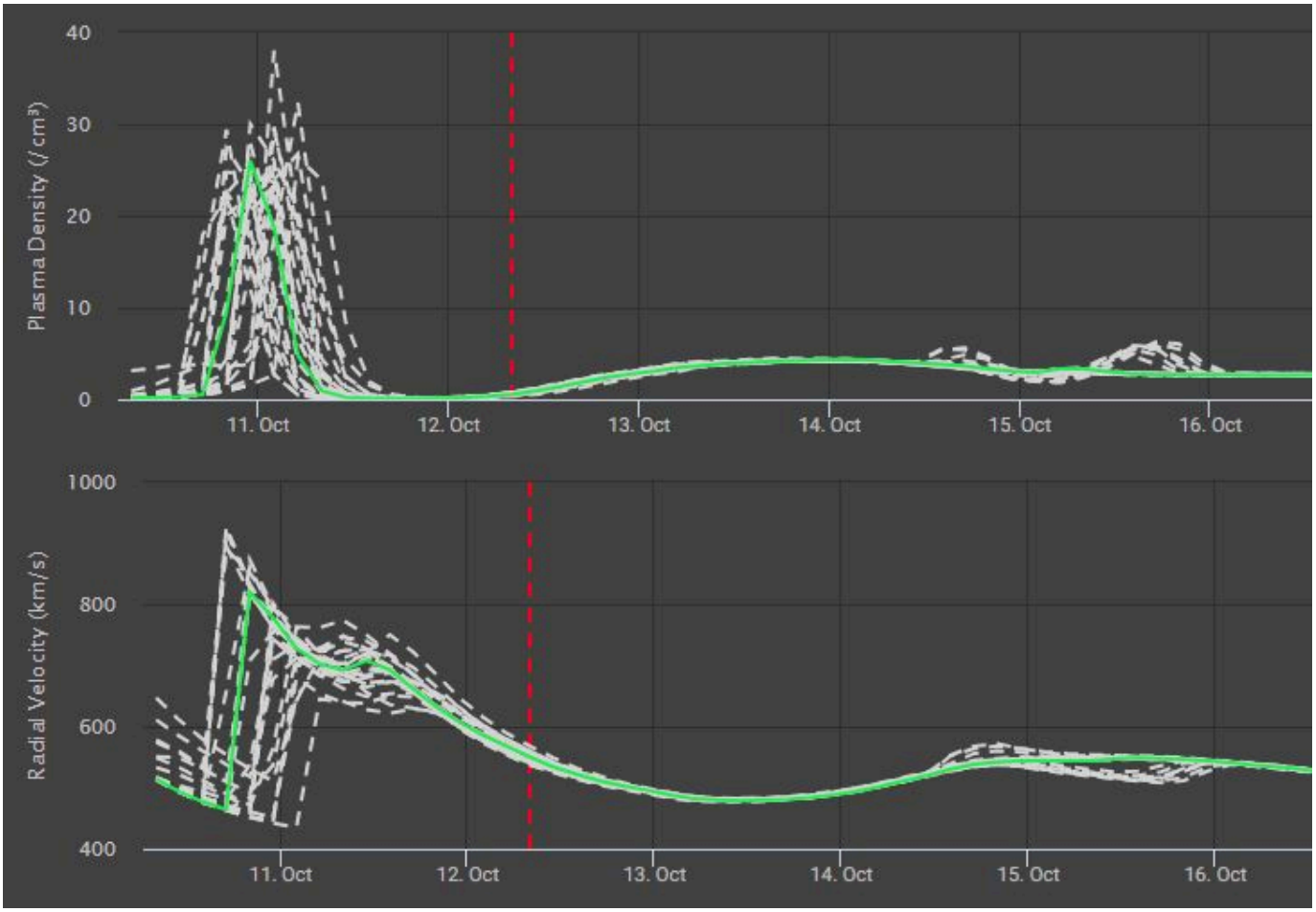
Figure 3: MOSWOC Enlil Ensemble - shows slight enhancement is possible 15 Oct due to glancing CME.



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Radio Blackouts - X-Ray Flares

The recent very active sunspot region Ex-AR3842 is now on the far side, however no further front-sided regions depart over the western limb in the four days. Going some way towards potentially mitigating against the loss of Ex-AR3842, the Carrington locations for two returning regions are due over the eastern solar horizon during the next 24 hours.

Added to these populating/depopulating factors is the consideration of a recently emerging sunspot region in the eastern hemisphere in the form of AR3854, which continues to show some slight growth and is one to watch as it approaches centre-disc (for CMEs).

All considered, the risks of further significant flares are now lower than in the recent past (when Ex-AR3842 was present as a front-sided feature). The risk sources for further flares are now much more well-spread across the disc: AR3848 has the history of such activity in the northwest; AR3849 is decaying (but is in a prone location for CMEs); and the southeastern AR3854 has been showing minor growth.

The significant flare risk level is therefore almost flat - after an initial slightly higher risk from Ex-AR3842 should it produce any very large events from beyond the west limb.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	65	60	60	60
Very Active	**R3-R5 (X Class)**	No	15	10	10	10

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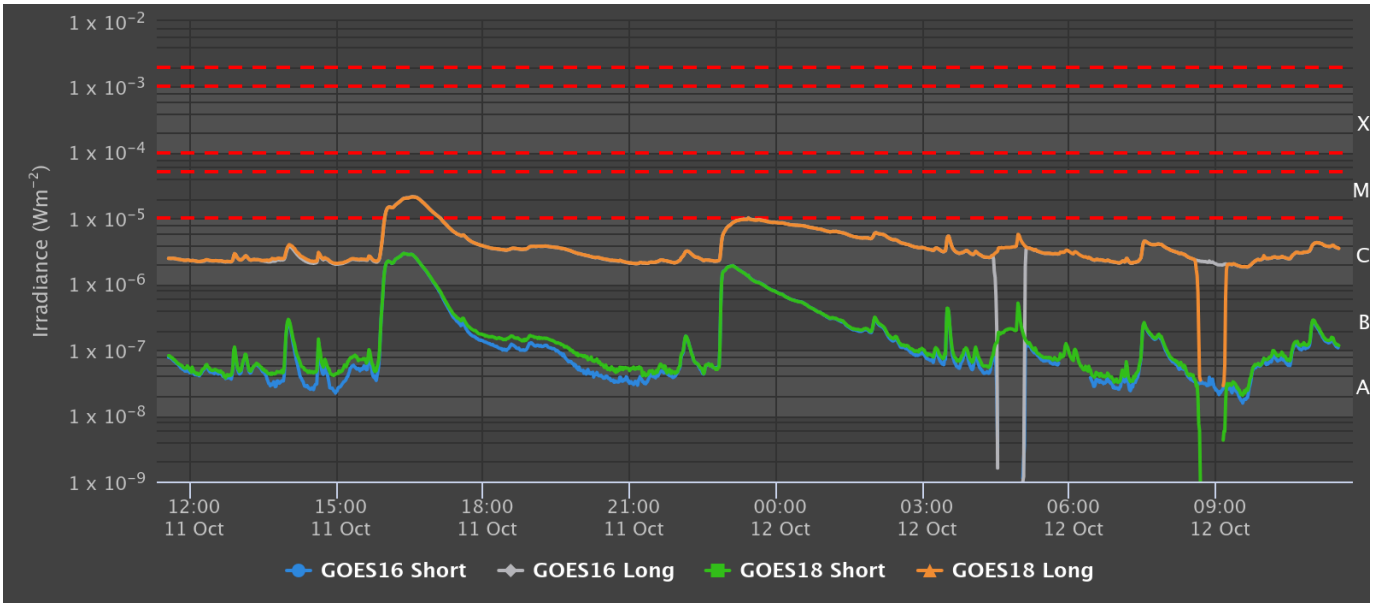
Figure 4: 24-hour X-Ray Flux



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Solar Radiation Storms (High Energy Protons)

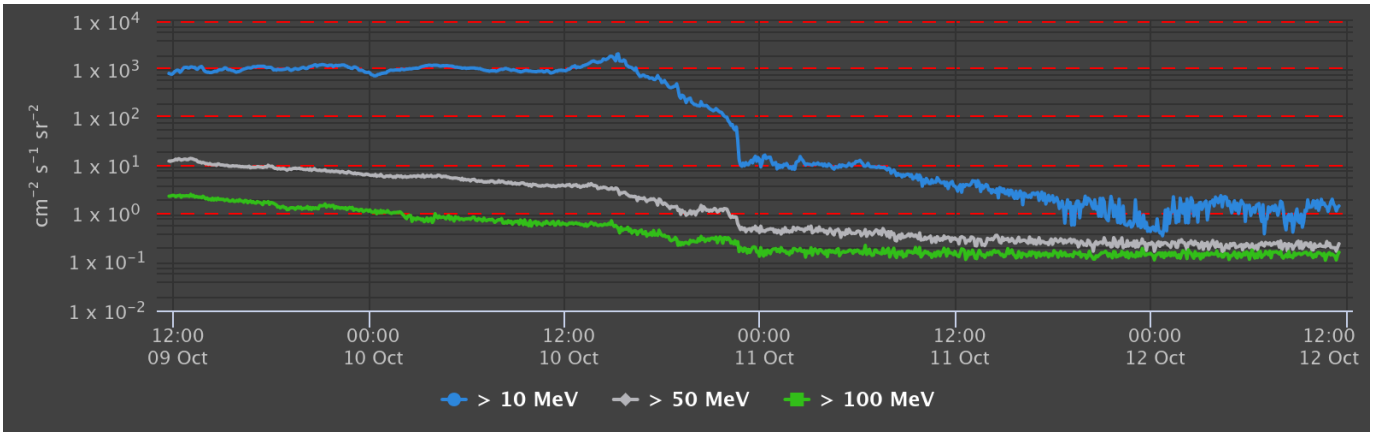
High energy proton flux at GOES18 has returned to background in the wake of the combined X1.8 and filament eruption on 09 Oct from the vicinity of AR3848 in the northwestern quadrant.

10MeV protons have now returned below the S1 threshold after initial enhancement but the risks of S-scale remain higher than raw values due to the ongoing slightly raised levels. Regarding potential new enhancements, AR3848 remains on the disc, and account must still be taken of AR3842's gradual retreat around the far side near 110W.

Overall, there remains a Chance of a return to S1 at first, relaxing to the residual risk for the current disc later in the UTC weekend as the counts in the near-Earth environment subside and Ex-AR3842 rotates sufficiently far beyond the west limb as to no longer pose a significant threat.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	20	15	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES Proton Flux for the last 3-days.



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) is currently between Normal Background and moderate levels after the 09 October CME arrival during the second half of 10 October compressed the outer Van Allen belt beyond GEO. These low counts at GEO are likely to continue on the 12 October. A gradual recovery to diurnal Moderate or High is possible through Day 2 (13 Oct) before any fast wind from CH79/+ (or perhaps CH77/-) takes effect, should either arrive.

There is a rising Slight Chance of Active 24-hour integrated fluence, probably peaking later in the UTC weekend given the forecast described above. MOSWOC REFM is not considered useful in this situation given the utter dominance of a large CME early in its evolution, and then the expected dissimilarity of the coronal holes' fast winds on this rotation.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	10	20	20	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: GOES16 Electron Flux

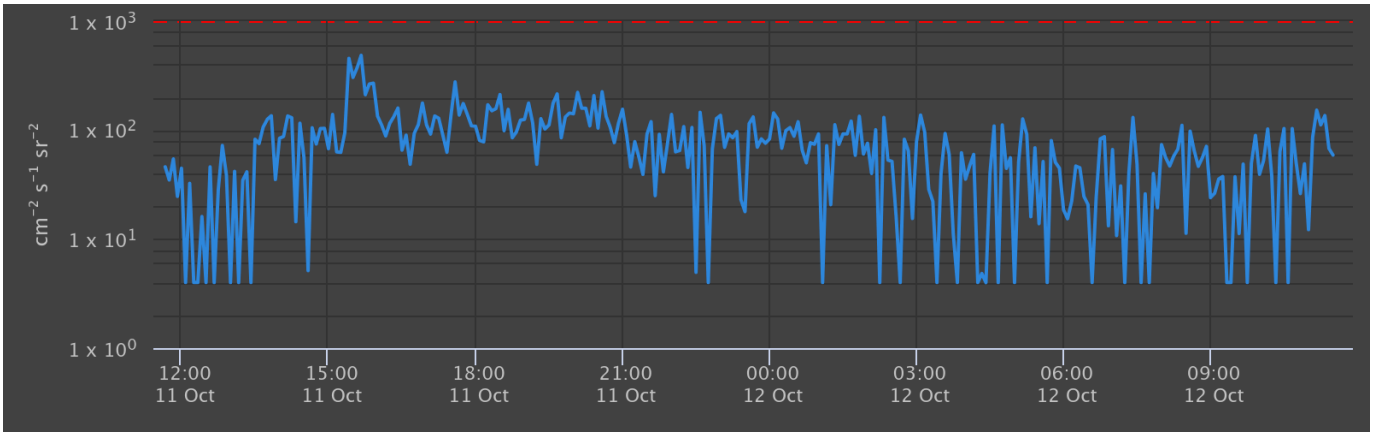

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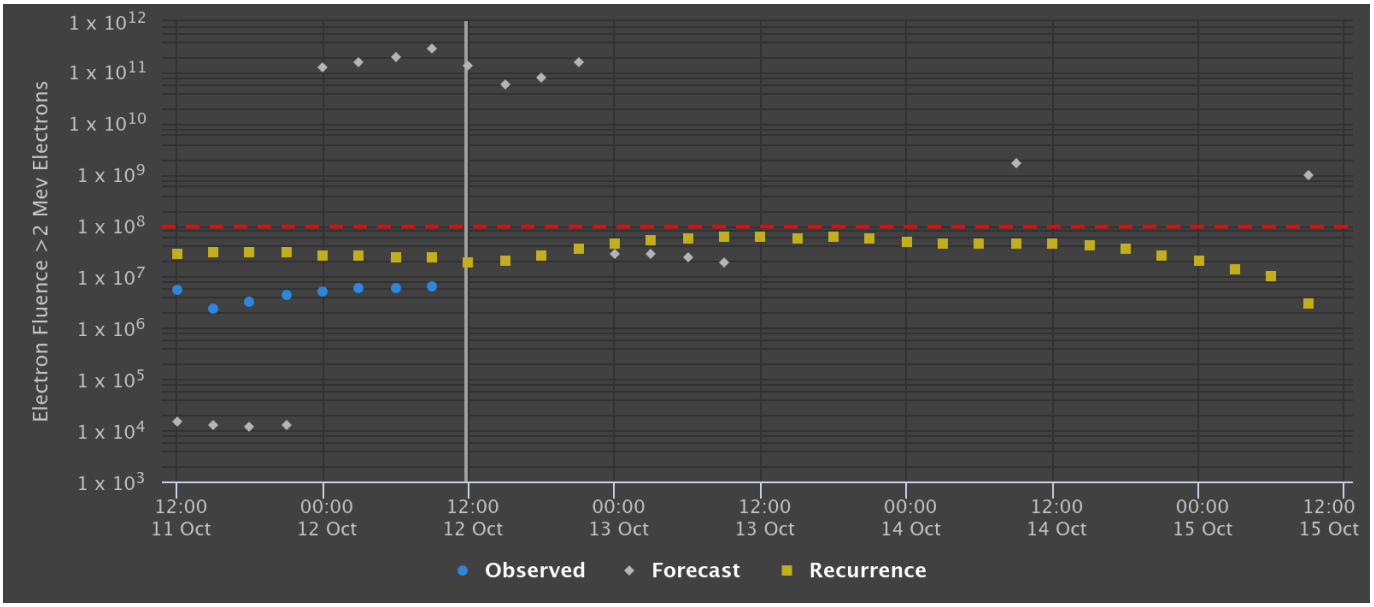
Figure 7: MOSWOC REFM - Electron Fluence.



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